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Abstract

NONDESTRUCTIVE TESTING OF NUCLEAR REACTOR COMPONENTS

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Design criteria, materials, and fabricating processes for nuclear reactor components are not sufficiently perfect to guarantee the high standards of quality required for functional and safety reasons. Even with the best manufacturing processes, properly controlled and executed, there are inherent flaws. Nondestructive testing provides a way of detecting the presence of inhomogeneities in materials without damage to the material.

During the past several years much information on nondestructive testing of nuclear reactor components has been accumulated. The research and development on nondestructive testing has provided assistance for improving the quality and reliability of reactor components. As a result of this research and development program, improvements have been made in old methods and techniques; new methods and techniques have been developed, and specialized instrumentation has been evolved. The sensitivity and resolution of all techniques are continually being improved.

Nondestructive testing of components for reactor systems differs from ordinary industrial nondestructive testing because the specifications for the nuclear systems are more rigid than those required in most other industries. The sensitivity and resolution required of the tests are in excess of those that can be justified on a cost basis in most industrial applications.

Detecting flaws and measuring material properties are among the useful applications of nondestructive testing. Requirements for quality work extends from the raw material through the completely fabricated component. One of the most valuable aspects of nondestructive testing is its effect on maintaining the quality of fabricated components and improving processes.

This paper summarizes the significant research and development in nondestructive testing since 1958 by various U. S. Atomic Energy Commission sites and contractors. The paper will include the application of nondestructive testing to fuel elements, tubing, piping, and pressure vessels. The methods to be discussed include acoustics (sonics and ultrasonics), penetrants, penetrating radiation (X-rays, gamma rays, beta rays and neutrons), eddy currents, leak, and thermal. Specific problems to be discussed include bond integrity, clad integrity and thickness, grain size and orientation, weld integrity, Uranium 235 content, fuel homogeneity, and component spacing. The special techniques to be described include Lamb waves, neutron radiography, scintillation spectrometry, high and low voltage radiography, remote inspection, backscatter laminography, pulsed eddy currents, and ultrasonic imaging. The advantages and limitations of and standards for the various methods and techniques will be evaluated.